

Theories of Money Demand: A Standard Study – Algeria (1990-2022) -

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Abstract:

The research paper aims to measure the determinants of money demand in Algeria. To achieve this goal, we analyze the long-term relationship between the following variables: the money supply as a dependent variable, and gross domestic product, inflation, and real exchange rate as independent variables using standard methods based on conducting stationary tests, cointegration tests, and using the autoregressive distributed lag model over the period 1990-2022. The results indicate the existence of a long-term equilibrium relationship between the variables.

Keywords: Money demand; Cointegration; Algeria; ARDL-ECM

1. INTRODUCTION

The theories regarding demand for money are divided into three schools: the classical school, which considers that the demand for money is a demand for goods and services; the Keynesian school, which sees the demand for money as being driven by three main motives - transactions, precautionary, and speculative - and this theory assumes an unstable function for the demand for money. On the other hand, the monetary school views the demand for money as a special case of the general theory of demand, where it constitutes one of the assets of wealth. This theory is based on the stability of the function of the demand for money. The more stable the function of the demand for money or the ability to predict changes that may occur to it, the greater the effectiveness of monetary policy in achieving its objectives. Therefore, this research paper aims to study the function of demand for money in Algeria from 1990 to 2022, with the goal of identifying the importance of monetary policy tools used by monetary authorities to achieve the goal of economic growth. We will

estimate the demand for the money function in Algeria and determine the most influential variables using the cointegration technique, which goes through several stages. In the first stage, we determine the degree of time series integration for the variables involved in the equation, then determine the model's lag period, estimate the number of cointegrating relationships, and then determine the cointegrating relationship between variables over the long term.

Study problem: The problem of this study can be formulated in the following main question:

What are the determinants of the demand for money function in Algeria?

The following sub-questions fall under this problem:

What are the variables that determine the demand for money function in Algeria?

Is the demand for money function stable in Algeria?

Study Hypothesis:

This study proceeds from the following hypotheses:

First hypothesis: there is an effect of gross domestic product, inflation, and exchange rate on the demand for money in Algeria with statistical significance.

Second hypothesis: the demand for money function is stable in Algeria.

Study objectives:

The main objective of this study is to identify the variables that explain the demand for money in Algeria during the period from 1990 to 2022, in addition to the following:

- Highlighting the theoretical basis for the demand for money.
- Reviewing the reality of the demand for money in Algeria during the study period.
- Identifying the standard model used.
- Estimating the demand for money function in Algeria.

Study methodology:

The study relies on the descriptive methodology to highlight the theoretical basis for the demand for money and review the reality of the demand for money in Algeria, and the standard methodology to estimate the

demand for money function. The following statistical tests were used: Unit Root Test to test the stability of time series, relying on the extended Dickey-Fuller test. Cointegration tests to test for common integration, estimating the autoregressive distributed lag (ARDL) model.

2. Theories of money demand:

The purpose of the theory of money demand can be identified by considering the variables that motivate people to hold a portion of their wealth in cash form instead of holding it in other asset forms.

2.1 Classical Monetary Theory:

We address the classical theory by presenting the assumptions of classical theory, the equations of the theory in addition to the criticisms (Belazouz , 2008, pp. 08-09)..

2.1.1 Assumptions of classical monetary theory:

a. Stability of transaction volume (exact volume of production):

The theory assumes that the volume of transactions and the level of economic activity are determined by objective factors that are not related to the quantity of money or the changes that occur in it. This may be due to the prevailing idea at the time that the national economy - in any society - is constantly in a state of equilibrium at full employment level. This assumption is one of the components of classical thought, which believes that the economic system has the self-capacity to automatically transform towards the level of employing workers for productive resources.

b. Stability of money velocity:

This theory assumes that the velocity of money is constant in the short term and is determined by slowly changing factors that are independent of the quantity of money, and thus it is considered as an external variable.

c. The quantity of money determines its value:

The quantity of money is considered the effective factor in determining value (purchasing power). For example, doubling the quantity of money leads to a halving of its purchasing power, and in other words, it is the important and effective factor in influencing price movements.

2-1-2 Quantity theory of money equations:

One of the most important equations in the quantity theory of money is Fisher's equation of exchange and the cash balance equation or Cambridge equation of demand for money, which are as follows:

a. Fisher's equation of exchange:

The classical theory of demand for goods and services interprets the relationship between the quantity of money and the general price level. This theory confirms the proportional relationship between the quantity of money on one hand and the general price level on the other hand. Therefore, Fisher's quantitative theory is a function of the general price level (P) as a fixed variable and the quantity of money (M) as an independent variable, assuming that the quantity of transactions (T) and the velocity of money circulation (V) are constant. The equation can be mathematically formulated as follows:

$$M.V = T.P \text{ (1)}$$

The quantity of money multiplied by its velocity equals the quantity of transactions multiplied by the general price level. Thus, whenever the quantity of money changes, the general price level changes in the same direction, provided that the quantity of transactions and the velocity of money circulation remain constant.

b. The cash balance equation:

The Cambridge version, presented by the economist at the University of Cambridge in England, posed an additional question(Yamden , 2011, p. 772): Why do individuals want to hold assets in the form of cash liquidity? The Cambridge equation of demand for money is represented by the equation:

$$M_d = T.P.K \text{ (2)}$$

Where M_d is the demand for money, K is a portion of real money, the income individuals want to hold in the form of cash, P is the price level, and Y is the total real income.

Alfred Marshall believed that economic agents tend to hold liquid cash balances to meet their purchases of goods and services, which he called "the preference for money." This analysis is based on the factors of individuals' demand for money to hold it in the form of idle cash balances and the

2-2-The Keynesian Theory:

Since Keynes was a contemporary of classical economists at the University of Cambridge, he followed the approach developed by his predecessors in the quantity theory of money, and his theory of demand for money was called the liquidity preference theory (Maryam & Abd Al-Hakim, 2020, p. 304). Keynes's total demand for money includes demand for money for speculative, transactional, and precautionary motives. Thus, the total demand function can be obtained by adding the demand function for money for transactional and precautionary motives to the demand function for money for speculative motives. This is called the monetary preference function and is expressed as follows:

$$\mathbf{Md} = \mathbf{L}(\mathbf{Y}, \mathbf{i}) = \mathbf{L1}(\mathbf{Y}) + \mathbf{L2}(\mathbf{i}) \quad (3)$$

The mathematical formula is:

$$(\mathbf{M/P})\mathbf{d} = \mathbf{Ky} - \mathbf{hi} \quad (4)$$

Where k is the change in demand for money for transactional and precautionary motives resulting from a change in income, and h is the change in demand for money for speculative motives resulting from a change in interest rates.

2-2-1 Key points of Keynesian theory:

It refers to the motive behind holding money, which is a medium of exchange to facilitate transactions(Al Rasasi , 2016, p. 09). There is a positive relationship between income and demand for money because an increase in income and expenditures requires people to hold more money.

Precautionary motive for unexpected events: There is a positive relationship between the demand for money and income.

Speculative motive or liquidity preference: money functions as a store of wealth.

- People can store wealth in the form of money or bonds: In other words, people prefer to hold bonds with a higher interest rate rather than money.
- There is a negative relationship between the interest rate and the holding of money.

2-3- Contemporary Monetary Theory by Milton Friedman:

Milton Friedman redefined the Quantity Theory of Money as a theory of money demand, rather than a theory of the general level of prices or income. He assumed that demand for money, like demand for any other asset, produces a flow of services for the holders of money, and is related to three main factors (Mostafa & Abdel-Qader, 2019, p. 30):

- Wealth constraint, which determines the maximum amount of money that can be held.
- The return on money compared to the returns on other financial and real assets that can form an individual's wealth.
- Asset holders' tastes and preferences.

According to Friedman, the way in which total wealth is distributed among different assets depends on the relative return of each asset. These assets include not only money and bonds, but also stocks and physical goods. Friedman believes that the marginal rates of return on assets are equal in equilibrium. Friedman's theory is a more comprehensive and broader analysis of the demand for money than classical and Keynesian analysis. Statistical studies have shown that as long as the velocity of money is stable and regular, there is a direct relationship between income and the quantity of money (as an expression of monetary policy). Based on the above, the general formula for money demand in Friedman's theory can be presented as follows:

$$\left(\frac{M}{P}\right) d = f\left(w, \mu, Y_p, \frac{1}{p} \cdot \frac{dp}{dt}, rb - \frac{1}{rb} \cdot \frac{dp}{dt}, re - \frac{1}{re} \cdot \frac{dre}{dt} + \frac{1}{p}\right) (5)$$

According to Friedman, the demand for money in the long run does not take into account changes in bond and stock prices, and price fluctuations tend to level off in the long run. The money demand function has been simplified by using permanent income instead of current income as a substitute for wealth. Permanent income is the weighted average of expected future incomes, and thus the previous money demand function can be reformulated to obtain the following simplified formula:

$$\left(\frac{M}{P}\right) d = f(w, \mu, Y_p, rb, re) (6)$$

Where: (M/P) is the demand for real balances, W represents the relationship between human capital and non-human capital, μ is tastes and

preferences, and r_b and r_e are the nominal rates of return on money and other assets, respectively.

A function of the velocity of circulation can be derived, which represents the ratio of income to the amount of money individuals wish to hold, i.e.

$$V = \frac{Y}{Md}(7)$$

Friedman stated in 1956 that demand for money must be driven by the same factors that affect demand for any assets ([Harun & Erdogan, 2020, p. 131](#)). Therefore, Friedman's money demand function emphasizes that wealth should be a more stable indicator than current income.

Friedman also contributed to the theory of money demand. Friedman's equation for money demand indicates that the function of money demand is determined by permanent income, bond and stock expectations, and inflation expectations ([Odior & Alenoghena, 2016](#)). There is a difference of opinion between Keynes and Friedman regarding the role of interest rates in influencing money demand. Friedman argues that money demand is insensitive to interest rates, while Keynes considers money demand to be highly sensitive to interest rates. Keynes and Friedman also differ on the velocity of money. Keynes believes that the velocity of money is unstable and unpredictable, while Friedman believes the opposite, that the velocity of money is stable and highly predictable ([Mishkin, 2004, p. 528](#)).

2-4 New Keynesian Theory:

The ideas of the new Keynesian theory began to emerge after World War II by a group of economists who believed in Keynesian ideas([Samira, 2015, p. 93](#)). They developed and improved upon the shortcomings of Keynesian analysis, with some of the prominent economists being James Tobin and William Baumol. The modern Keynesian analysis highlights the limitations of traditional monetary sector analysis by assuming that investors hold diverse portfolios containing a variety of assets, not just money and bonds. Furthermore, traditional Keynesian analysis assumes that investors face a certain choice between money and bonds, whereas in reality investors hold both. J. Tobin emphasized the inability of investors or wealth holders to have a precise and certain expectation of interest rates. This uncertainty leads to the existence of a diverse portfolio that reduces

risk and maximizes profits. The ratio of money to bonds in this portfolio changes as interest rates change. Therefore, the investment portfolio theory revolves around the objectives that determine the investor's choice of financial assets within the investment portfolio, with two main objectives being to maximize returns and minimize risks.

2-4-1 William Baumol's contributions:

His achievements in the demand for money were represented by his introduction of the inventory model. Its mathematical formula was as follows(Radhia & Sahraoui, 2015, pp. 98-99):

$$Mt = \frac{1}{2} \sqrt{\frac{2 \cdot b \cdot y}{i}} = \frac{1}{2} \cdot \sqrt{2b^{0.5} y^{0.5} i^{-0.5}} \quad (7)$$

Mt: Demand for money for transactions.

Y: Nominal income.

i: Interest rates.

b: Transaction costs from brokerage fees and transfer commissions.

Based on this equation, Baumol's results were:

- The demand for money for transactions is directly related to nominal income (Y) and inversely related to interest rates (i) as an alternative opportunity cost.
- An increase in transaction costs (b) leads individuals to refrain from investing in bonds and prefer to hold them in liquid form to meet current needs. If they are nonexistent, then the demand for money will be nonexistent too, as individuals will choose to invest all of their income in bonds.
- The income elasticity of demand for money in this model is 0.5, unlike what the quantity theory suggests, which is that the income elasticity of demand for money is equal to 1.
- The price elasticity of demand for money with respect to interest rates is -0.5. Since economic units seek to hold a real quantity of money with purchasing power, the demand for money in Baumol's model is a function of real income and interest rates and can be written mathematically as follows:

$$\frac{Mt}{P} = f(Yr; i) \quad (8)$$

Baumol's discovery in the inventory model is that the demand for money for transactions is sensitive to changes in interest rates, which is an innovation and a support for interest rates as determinants of the demand for money.

2-4-2 James Tobin's contributions:

James Tobin's contributions on the demand for money were for speculative purposes and were represented in two models: the portfolio balance model and the backward-looking expectations model. Tobin's contributions to the backward-looking expectations model were that individuals differentiate between holding non-yielding money and bonds that provide financial gains to the holder, based on their expectations of interest rates. He also found through his studies that as the current interest rate rises, the expected interest rate also rises, but to a lesser extent, which he called the backward-looking expectations. When the current interest rate (i) falls, individuals gradually agree to relinquish their bond holdings in exchange for liquidity, thus allowing an individual to have a portfolio consisting of both money and bonds. This is contrary to Keynes' analysis, which only focused on individuals having either money or bonds.

In the portfolio balance model, Tobin relied on the inherent uncertainty of individuals regarding future interest rates, which leads to an explicit recognition of the risks that capital losses can result from holding bonds. This was a driving force for individuals to diversify their portfolios with combinations of money and bonds, with each asset having two advantages: the expected yield and the risk resulting from holding it. He explained that a portfolio with high risks can achieve capital gains, but can also result in losses. In contrast, a portfolio with low risks, while providing protection against losses, does not provide the holder with the hope of achieving exceptional profits.

As a result, economic units seek to hold the optimal amount of liquid non-yielding cash balances and bonds that offer returns accompanied by risks, so that the total wealth (money and bonds) of the investor forms a diversified portfolio.

One of the results of this model is that the higher the interest rate, the more it leads to a shift in bond ownership in exchange for giving up cash.

This means that there is an inverse relationship between the demand for money for speculative purposes and the interest rate. This is what Keynes concluded, as he also found that as risk increases by decreasing amounts, even if interest rates remain constant, this is accompanied by a decreased amount of liquid wealth allocated to investing in bonds, meaning a decrease in demand for money in decreasing amounts. Thus, risk affects consisting of both cash and bonds. With these results reached by James Tobin, the balanced portfolio model became the basis of the theory of demand for money for speculative purposes.

2-5 Modern Financial Innovations:

As (Dou Xiangsheng, 2018, p. 6) observes, financial innovations bring about changes in all the variables that determine the demand for money, including the fundamental variable, the scale variable, the opportunity cost variable, and other variables in the function of money demand. Typically, all analysts, including those in the Keynesian and monetary schools, agree that the scale variable (income or wealth variable) is the most important in the functions of money demand. However, the emergence of new financial tools gives importance to the impact of opportunity cost and other variables. This is because new financial tools reduce the costs of switching between money and other assets subtitle.

3. Literary review:

3- 1 First study:

A study titled "The Role of Remittances in the Stability of Money Demand in Pakistan: A Cointegration Analysis" by Niaz Hussain Ghumro and Mohd Zaini Abd Karim (2017). Discusses the importance and role of financial remittances in stabilizing money demand in Pakistan over a period from 1972 to 2014, using the autoregressive distributed lag (ARDL) model and the following independent variables: real income Y_t , discount rate I , real exchange rate RER , and financial remittances RM . The dependent variable is the real narrow money balances $M1$ and then the real broad money balances $M2$ were used. The researcher found that financial remittances have a positive impact on narrow money balances ($M1$) only. Therefore, authorities should use narrow money supply rather than broad

money supply as a tool to control monetary policy and thus improve consumption and promote economic growth.

3. 2 Second study:

The study by Simplice A. Asongu, Oludele E. Folarin & Nicholas Biekpe (2018) titled "The Long Run Stability of Money Demand in the Proposed West African Monetary Union" aims to investigate the demand for money in the proposed West African Monetary Union (WAMU). The study uses a standard money demand function and estimates it using the ARDL bounds testing approach to cointegration and error correction modeling, with the following independent variables: Gross Domestic Product (GDP), inflation (INFL), and exchange rate (EXCH). The study uses annual data for the period from 1981 to 2015 from fifteen member states of the Economic Community of West African States (ECOWAS). The dependent variable is real money balances 2M. The results indicate differences across member countries in the Economic Community of West African States in the stability of money demand. These differences are attributed to variations in cointegration, short- and long-run determinants, and error correction in response to shocks.

3. 3 Third study:

The study by Mustafa Abdelatif and Mourad Abdelkader's (2019), entitled "Analysis of the demand function for money in Algeria 1972-2010 using the cointegration approach," aimed to study the most important factors influencing the demand for cash balances in Algeria during the period from 1972 to 2010. The study used both the Dickey-Fuller and Phillips-Perron tests to test the stability of the study variables, as well as the Johansen methodology for cointegration analysis. The independent variable used was cash balances in the broad sense, while the dependent variables were real GDP, interest rates, exchange rates, discount rates, and inflation. The results indicated a one-to-one cointegration relationship between cash balances in the narrow sense and the monetary base, and interest rates, which means that the demand function for money is stable.

3. 4 Forth study:

The study by Mariem Mahsares and Saïd Abdelkrim's (2020), entitled "A Standard Economic Study of the Demand for Money Using Error

Correction Model: A Case Study of Algeria 1970-2017". Aimed to study the factors affecting the demand for money in Algeria during the period from 1970 to 2017 using the error correction model and the following independent variables: gross domestic product (GDP), exchange rate (TC), inflation rate (INF), and discount rate (TR). The dependent variable was real narrow money supply (M1). The researcher found that the demand for money in Algeria is positively affected by real GDP and negatively affected by the exchange rate and discount rate in the long run, as the speed of adjustment of the imbalance in the estimated system is estimated at 18.12.

4. Applied Study:

4.1 ARDL Model:

The ARDL model is a regression model that includes the current value (t), lagged dependent variable, and lagged independent variable. The ARDL method is a modern technique for examining long- and short-term relationships between dependent and independent variables. There are many advantages to the ARDL method, including that it does not require conducting a stationary test, but it is best to continue with the stationary test. It is assumed that all variables are internal, and ARDL models are suitable for small sample sizes and remove omitted variables and autocorrelations.

4.2 Study Variables:

Broad Money Supply: It is the total currency outside banks, demand deposits other than those of the central government, time deposits, savings deposits, foreign currency deposits for resident sectors other than the central government, bank and traveler's checks, and securities such as negotiable certificates of deposit and commercial papers. It is denoted by M2.

Inflation: It is the annual percentage change in the cost to the average consumer for a basket of goods and services that can remain constant or change over specific periods, such as a year. It is denoted by INF.

Gross Domestic Product: It is the monetary or market value of all final goods and services produced within a country during a certain period, usually a year. It is denoted by GDP.

Real Exchange Rate: It is the relative price of goods from different countries when measured in a common currency with the relevant country.

Thus, it represents the number of foreign currency units required to purchase one unit of domestic goods and is denoted by RER.

4.3 Description of study variables and their sources:

In this section, we will discuss the methodological aspects of the standard study used, starting with defining the study variables, providing a general description of them, and identifying their sources.

a. Description of Study Variables:

The following table presents the results of the description of the variables used in the model during the study period (1990-2022):

Table n°1: Description of Study Variables

	M2	IFN	RER	GDP
The Mean	56.573650	11.337080	43.220650	2.792210
The Median	57.265320	10.856320	41.267970	3.300000
Maximum Value	82.052530	53.788600	63.969730	7.201872
Minimum Value	33.005840	-11.189790	30.845200	-2.100001
Standard Deviation	14.071850	13.841350	12.211460	2.112982
Skewness Coefficient	-0.079720	0.742117	0.306665	-0.494739
Kurtosis Coefficient	2.029509	4.165225	1.486268	3.305365
Jarque-Bera Statistic	1.079582	4.741580	2.861387	1.165524

Source: Prepared by researchers based on the Eviews program

The above table shows the descriptive statistics related to the dependent variable, which is the broad money supply, and the independent variables, which are inflation, exchange rate, and GDP. The Skewness coefficient for each variable is different from zero, indicating the presence of asymmetrical distribution, and the Jarque-Bera statistic showed that the variables do not follow a normal distribution.

4.4 Data Sources:

The study relied on data from the World Bank to obtain variables such as money supply, inflation, and gross domestic product. As for the exchange rate variable, it was extracted from the CHELEM database. All data is in percentage terms, and this study was conducted using Eviews 9 software during the period from 1970 to 2022.

4.5 Testing the Stationarity of Time Series:

These tests aim to verify the existence of a unit root, which means the non-stationarity of the time series, or the absence of a unit root, which

means its stationarity, for both the monetary aggregate, exchange rate, GDP, and inflation during the study period.

Table n°2: Testing the Stationarity of Time Series

	At the level			At the first difference		
	ADF			ADF		
	The constant term and the general trend	The constant term	Without them	The constant term and the general trend	The constant term	Without them
M2	-3.31	-0.63	0.37	3.70-	3.54-	3.48-
INF	-4.92	-3.06	-2.45	6.16-	6.28-	6.23-
RER	-3.61	-0.95	-0.06	-4.35	-4.21	-4.11
GDP	-3.47	-3.2	-0.67	-5.27	-5.31	-5.37

Source: Prepared by researchers based on the Eviews program

Note that the tabulated t-value: At a significance level of 5%:

- 3.61 - according to the formula that contains a constant term and a time trend
- 2.98 - according to the formula that contains a constant term
- 1.95 - according to the formula that does not contain either a constant term or a time trend

It can be seen from the table above that all the variables under study are non-stationary at the Level where the calculated t-values are smaller than the tabulated t-values at a significance level of 5%, whether there is a constant term or in the case of the constant term and time trend, or without them. Therefore, the hypothesis of the absence of a unit root, i.e. the non-stationarity of the time series, is accepted.

By performing the same test for first differences, the time series became stationary, as the calculated t-values were larger than the tabulated t-values at a significance level of 5%, whether there is a constant term or in the case of the constant term and time trend, or without them. Therefore, the hypothesis of the absence of a unit root, i.e. the non-stationarity of the time series, is rejected at the first difference level, indicating that they are integrated of the order one $I(1)$. It can be concluded that the time series for all the variables under study are non-stationary at their original level, but after taking the first differences of these variables, they became stationary.

This was based on the automatic lag selection for the program used, Eviews. Therefore, the time series for the variables under study are integrated of the same order, which is the first order, indicating the possibility of their common integration.

4.6 Joint Integration Test (Bound Test):

After ensuring the stability of the time series variables under study and that they are integrated at the same degree, which is the first degree (1)I, a test for the existence of a long-term equilibrium relationship between the time series will be conducted using the Joint Integration Test (Bound Test). This test requires determining the appropriate number of lag periods, and to test the optimal number of lag periods, the VAR Lag Order Selection Criteria test is used. which relies on the following criteria: Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SC), Hannan-Quinn Criterion (HQ), Final Prediction Error Criterion (FPE), and Likelihood Ratio Criterion (LR).

The results showed that the appropriate number of lag periods is 1, and the following table shows the results of selecting the lag period.

Table n°3: Model Lag Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-312.152	NA	3251802	26.34604	26.54238	26.39812
1	-251.758	95.62476*	82432.80*	22.64649	23.62820*	22.90693*
2	-235.494	20.32941	91752.22	22.62453	24.39161	23.09333
3	-218.064	15.97746	117314.3	22.50536*	25.05781	23.18253

Source: Prepared by researchers based on the Eviews program

* Refers to the lag period selected by the criterion

The lag period of 1 was selected by all criteria except for AIC, which chose a lag period of 3. Therefore, the optimal lag period is 1 according to the SC criterion.

The results of the Johansen cointegration test are as follows:

$$\begin{aligned}\Delta Y_t = & \alpha_1 + \sum_{i=1}^p \beta_1 \Delta Y_{t-i} \\ & + \sum_{i=0}^p \beta_2 \Delta x_{1t-i} \\ & + \sum_{i=0}^p \beta_3 \Delta x_{2t-i} + \sum_{i=0}^p \beta_4 \Delta x_{3t-i} + \sum_{i=0}^p \beta_5 \Delta x_{4t-i} + \rho_1 u_{t-1} \\ & + \rho_2 X_{1t-1} + \rho_3 X_{2t-1} + \rho_4 X_{3t-1} + \rho_5 X_{4t-1} + \dot{\varepsilon}_t\end{aligned}$$

Hypothesis of the model:

H0: $\rho_2 = \rho_3 = \rho_4 = \rho_5 = 0$, there is no integration.

H1: $\rho_2 \neq \rho_3 \neq \rho_4 \neq \rho_5 \neq 0$, there is integration.

Table n°4: Joint Integration Test (Bound Test)

F Statistic		Bound Critical Value $\alpha=5\%$
I0 Bound		I1 Bound
6,275	2,86	4,01

Source: Prepared by researchers based on the Eviews program

Table 4 shows the results of the Joint Integration Bound test in this study. The research hypothesis for joint integration is as follows: If the F-statistic is greater than the critical value of I0 Bound (2.86) and I1 Bound (4.01), then H0 hypothesis, which indicates no joint integration, is rejected, and H1 hypothesis, which suggests joint integration, is accepted. These results indicate that the variables of money supply, inflation, exchange rate, and gross domestic product have a long-term relationship.

a. Estimation of the Cointegration Model Equation:

$$M2 = -0.28 * INF + 0.92 * RER + 0.94 * GDP + 17.30$$

Table n°5: Estimating the money demand function in Algeria using the cointegration method.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF	-0.28853	0.16186	-1.78256	0.08850
RER	0.92023	0.16584	5.54893	0.00000
GDP	0.94820	1.00050	0.94773	0.35360
C	17.30913	9.63752	1.79601	0.08620
R-squared	0.74350			
S.E. of regression	7.73455			

Long-run variance	92.43397
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Source: Prepared by researchers based on the Eviews program

b. Economic Aspect:

Regarding the demand for money in Algeria, it has a positive relationship with both the gross domestic product and the exchange rate and an inverse relationship with inflation. This is consistent with economic theories, whether related to Keynesian theory or monetary theory.

c. Statistical Aspect:

- The probability for the inflation variable is 0.08, which is less than 5%. This indicates that inflation explains the monetary aggregate.
- The probability for the exchange rate variable is 0.00, which is less than 5%. This indicates that the exchange rate explains the monetary aggregate.
- The probability for the gross domestic product variable is 0.35, which is greater than the significance levels of 10%, 5%, and 1%. This indicates that the gross domestic product does not explain the monetary aggregate.

$R^2 = 0.74$, which means that the variables explain 74% of the changes in the monetary aggregate.

d. Estimating the ARDL Model Equation:

Table n°6: Estimation of the demand function for money in Algeria using the ARDL model.

Variable	Coefficient	Std. Error	Prob.
C	-0,0561	0,0241	0,0237
M2t-1	0,4266	0,1174	0,0006**
M2t-2	0,2802	0,1255	0,0295**
M2t-3	0,2537	0,1268	0,0502
M2t-4	-0,3319	0,1088	0,0035**
INF 1t	0,1780	0,4205	0,6736
INF 1t-1	0,2222	0,5250	0,6737
INF 1t-2	-15,067	0,4737	0,0024**
RER 2t	0,0861	0,0365	0,0216**
GDP t	0,0288	0,1103	0,7947
R-Square			0,79
Adj. R-Square			0,75

Source: Prepared by researchers based on the Eviews program

Where (**) is significant at a 5% level.

The ARDL results shown in Table 6 indicate that the null hypothesis suggests that the independent variables do not have a significant impact on the dependent variable, which cannot be rejected, while the alternative hypothesis suggests that the independent variables have a significant impact on the dependent variable, which can be rejected. The conclusion is that the exchange rate and inflation have a significant impact on the demand for money, while GDP does not have an impact on the demand for money. Table 6 also shows that the model is relatively good, as it has an R-Square value of 79% and Adj-R of 75%, meaning that the independent variables of exchange rate, inflation, and GDP explain 75% of the money supply. The long-term estimation results in this study are presented in Table 7 below.

Table n°7: The long-term estimation results

Variable	Coefficient	Std. Error	Prob.
C	-0,1510	0,0757	0,0507
INF t	-51,342	12,625	0,0001**
RER t	0,2318	0,0958	0,0187**
GDP t	0,0777	0,3009	0,7973

Source: Prepared by researchers based on the Eviews program

Where: (**) significant at 5% level

The long-term estimates in Table 7 show that the inflation variable (INF) and the exchange rate (RER) have a significant positive impact on the money supply (M2). This is because the probability of these variables is less than $\alpha = 0.05$, where the null hypothesis suggests that the independent variable does not have a significant effect on the dependent variable, which is rejected. The long-term results in Table 7 also show that the GDP variable does not have a significant impact on the money supply (M2). This is because the probability of this variable is greater than $\alpha = 0.05$, so the null hypothesis suggests that the independent variable does not have a significant effect on the dependent variable, which cannot be rejected, i.e., the null hypothesis is accepted.

The following explanation is an analysis of the short-term estimation results. The short-term estimation results can be seen in Table 8 in this study below:

Table n°8: The short-term estimation results

Variable	coefficient	Std. Error	Prob.
$\Delta M2t-1$	-0,2020	0,1146	0,0833
$\Delta M2t-2$	0,0782	0,1190	0,5137
$\Delta M2t-3$	0,3319	0,1088	0,0035**
$\Delta INF t$	0,1780	0,4205	0,6736
$\Delta INF t-1$	-15,067	0,4737	0,0024**
$\Delta RER t$	0,0861	0,0364	0,0216**
$\Delta GDP t$	0,0288	0,1103	0,7947
ECT	-0,3714	0,0781	0,0000**

Source: Prepared by researchers based on the EvIEWS program

Where: (**) Significant at 5% level

Table 7 shows that the cash velocity delay is 3, the inflation delay is 1, and the exchange rate has a significant impact on cash velocity in the short term. This is because the probability of the variable is less than the level of $\alpha = 0.05$. The results show more on the variable of electroshock treatment. The variable transactions for electroshock treatment have a significant negative sign, allowing for short-term models and analysis. The coefficient of electroshock treatment is -0.37, so the process of adjusting the actual M2 mismatch with the desired M2 growth should be relatively quick because the coefficient of electroshock treatment is relatively large.

It is generally statistically safe to conclude from the above table results, as evidenced by the critical coefficient value of 0.74, indicating that the change in demand for money from its determinants is explained by 74%, while the remaining 26% is explained by other variables that were not included in the model.

Regarding the statistical significance tests, the Student's t-test confirms the statistical significance and validity of the constant, as well as the independent variables of inflation and exchange rate, as they both individually contribute to the impact on demand for money. However, the independent variable of gross domestic product (GDP) is not statistically significant and thus does not contribute to the impact on demand for money.

Furthermore, the Fisher's F-test confirms the strong statistical significance of the independent variables (inflation, exchange rate, and

GDP) collectively in explaining the dependent variable (demand for money).

The results of the diagnostic tests are also presented, with the Durbin-Watson test indicating that there is no significant autocorrelation of errors, as the value of 1.57 is close to 2.

The test for heteroscedasticity using ARCH indicates no measurement problem (instability of variance), as shown in the following table.

Table n°9: The test for heteroscedasticity using ARCH

Heteroscedasticity Test: ARCH			
F-statistic	0.693489	Prob. F(1,16)	0.4172
Obs*R-squared	0.747765	Prob. Chi-Square(1)	0.3872

Source: Prepared by researchers based on the EvIEWS program

Conclusion:

The stability of money demand is considered important in the economy of any country. Therefore, the aim of this article was to study the determinants of money demand in Algeria by estimating this function during the period of 1990-2016 using the Johansen cointegration model and the ARDL model. The study arrived at the following results:

First: Results of theoretical study

- The theories of demand for money, whether classical, Keynesian or Friedman's, attempted to determine the function of demand for money through proposed hypotheses and using several explanatory variables that helped us choose a set of variables that we used in the standard study.

Second: Results of standard study

- The results of stability tests using the unit root test showed that economic variables are not stable at the level, but became stable in the first differences.
- The variables are integrated in a common way and a long-term equilibrium relationship was found between the study variables (money supply in its broad concept, gross domestic product, exchange rate, and inflation).
- As for the evolution of money supply and real GDP, they went through two stages: the first stage saw GDP surpassing money

supply, while in the second stage, money supply surpassed GDP by a large margin.

- Estimation of the common integration equation showed a positive and significant causal relationship between inflation and demand for money and an inverse and significant relationship between exchange rate and demand for money. There was also a non-significant positive relationship between GDP and demand for money, which led us to conclude that GDP does not determine the money supply in Algeria, and therefore the explanatory variables have statistical significance. This supports the first hypothesis.
- The results of the error correction model (ECM) test showed that there is no long-term relationship between the variables, which means that the demand for money function is unstable, and therefore the second hypothesis is rejected.
- According to the results of the ARDL-ECM formula estimation, the demand for money in Algeria is generally flexible in the short and long term.
- In case of a shock to the demand for money function, it takes approximately 3 years and 2 months for it to return to its equilibrium, which indicates a relatively fast adjustment speed.

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